21-year-old female with papillary thyroid carcinoma

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History of Present Illness

- 21-year-old woman
- Saw her PCP to request a referral to dermatology
- Found to have a fullness in her neck on the left side → ultrasound → FNA → papillary thyroid cancer
- CT imaging concerning for left lymph node involvement
- No dysphagia, cough, shortness of breath, dysphonia

History of Present Illness

- No family history of thyroid cancer
- Employed as a radiation technologist in a veterinarian's office
  - Past three years (since age 19)
  - Each animal gets approximately three images while she is holding them
  - She hold four animals a day, three to four days a week
  - Wears a lead garment to cover her trunk but no thyroid collar

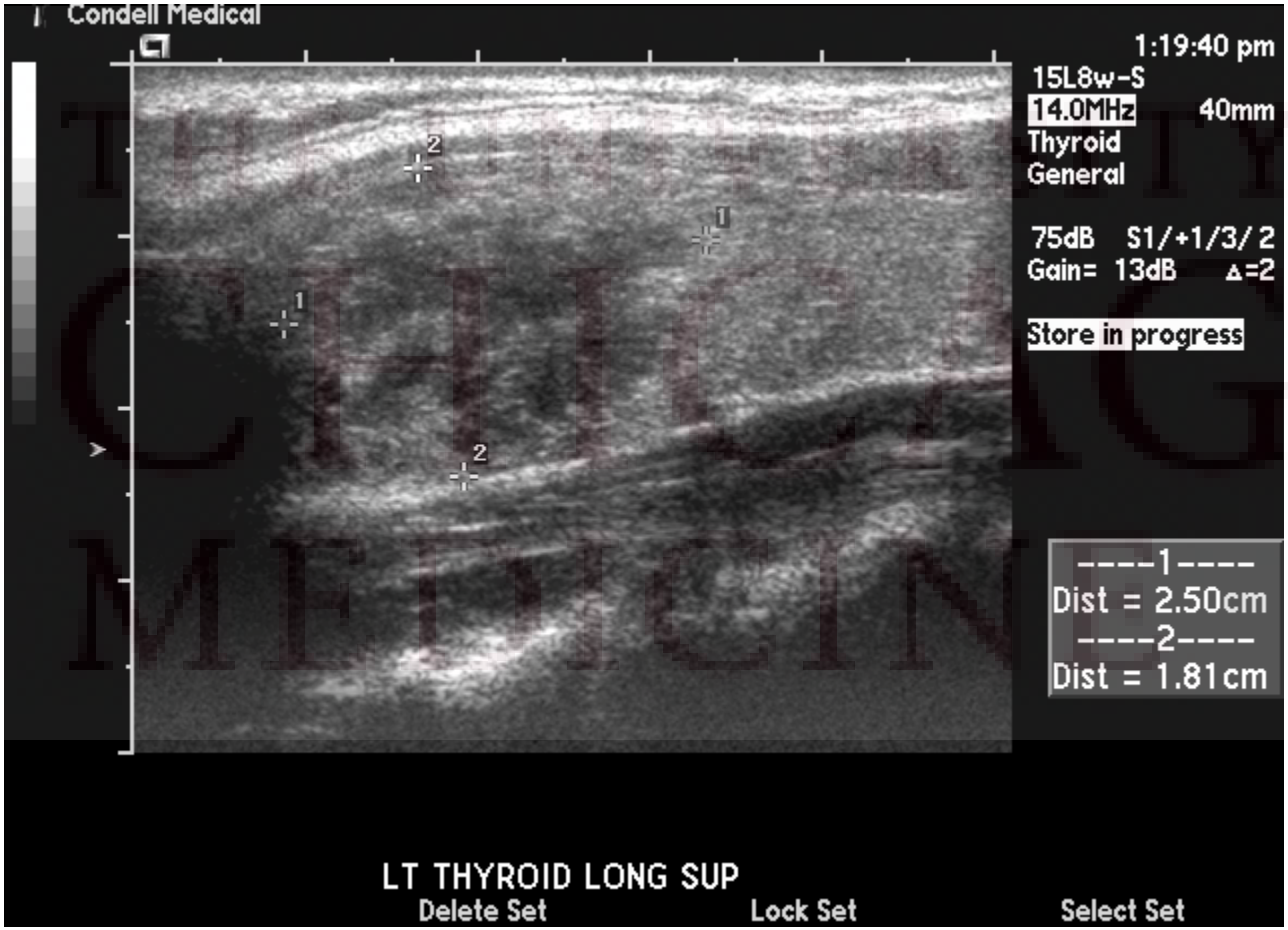
History

- Past Medical History
  - Gluten Sensitivity
  - Anemia
- Past Surgical History
  - Tonsillectomy, age 13
- Allergies: NKDA
- Medications: None
- Family History
  - Mother with history of nontoxic goiter, being evaluated for hyperparathyroidism
  - No thyroid cancer
- Social History
  - Employment
  - Tobacco, 5 cigarettes in lifetime
  - Rare alcohol use, No illicit drugs

Physical Exam

- Vital signs: BP 102/61, Pulse 58, Temp 96.3, RR 18 Ht 5’6”, Wt 155 lb
- Gen: well-nourished, no distress
- HEENT: EOMI, no Chvostek sign
- Neck: incision c/d/I, JP drain in left neck
- CV: regular rate, no extra heart sounds
- Pulm: good respiratory effort, lungs CTAB
- Abd: bowel sounds present, soft, nontender
- Neuro: sensation intact to light touch

Ultrasound

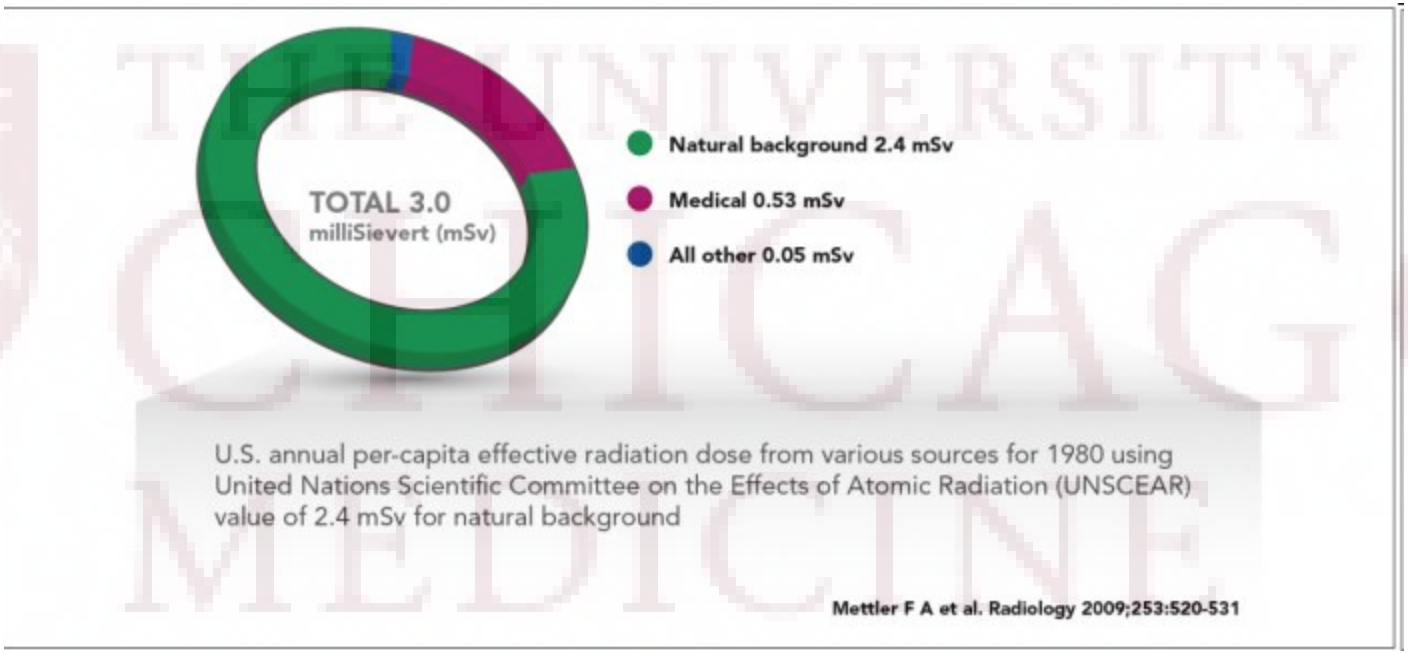

Condell Medical
1:19:40 pm
15L8w-S
14.0MHz
40mm
Thyroid
General
75dB S1/+1/3/2
Gain= 13dB Δ=2
Store in progress
----1----
Dist = 2.50cm
----2----
Dist = 1.81cm
LT THYROID LONG SUP
Delete Set
Lock Set
Select Set

Final Pathologic Diagnosis

- Complete thyroidectomy:
  - Papillary thyroid carcinoma, multifocal (largest nodule 2.5 cm)
  - Chronic lymphocytic thyroiditis
  - Parathyroid tissue without diagnostic abnormality
- Left neck contents, excision
  - Five level II lymph nodes, no tumor
  - Metastatic papillary thyroid carcinoma in 5 of 12 level III lymph nodes
    Metastatic papillary thyroid carcinoma in 2 of 4 level IV lymph nodes

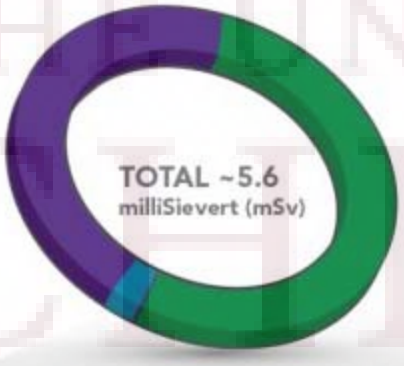
Radiation Units

- Activity: The number of times each second a radioactive material decays and releases radiation
  - Disintegration/sec=1 **Becquerel** (Bq)
  - 37 billion Bq = 1 curie
- Dose (absorbed): The amount of radiation energy absorbed into a given mass of tissue
  - 1 joule/kg = 1 **Gray**
  - 1 Gray = 100 rad (1 cGy = 1 rad)
- Dose (equivalent): energy per unit mass times adjustments for the type of radiation involved (quality factor) and the biological response in the tissue (a weighting factor)
  - Gray x quality factors= **Sievert** (Sv)
  - 1 Sievert =100 rem



U.S. annual per-capita effective radiation dose from various sources for 1980 using United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) value of 2.4 mSv for natural background

Mettler F A et al. Radiology 2009;253:520-531



- Medical 3.0 mSv
- Occupational 0.005 mSv
- Nuclear power 0.005 mSv
- Consumer products 0.13 mSv
- Natural background 2.4 mSv

U.S. annual per-capita effective radiation dose from various sources for 2006 using United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) value of 2.4 mSv for natural background

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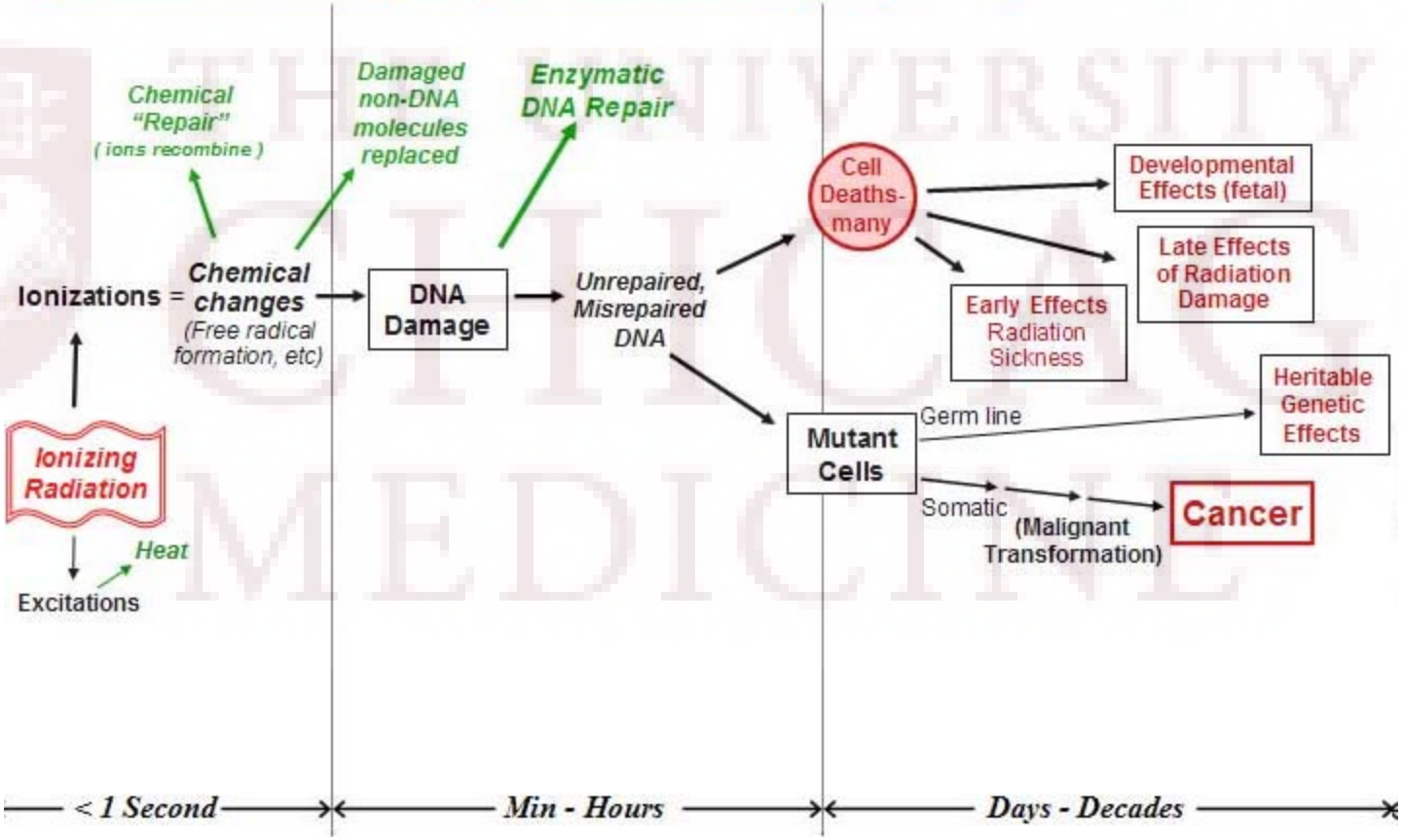
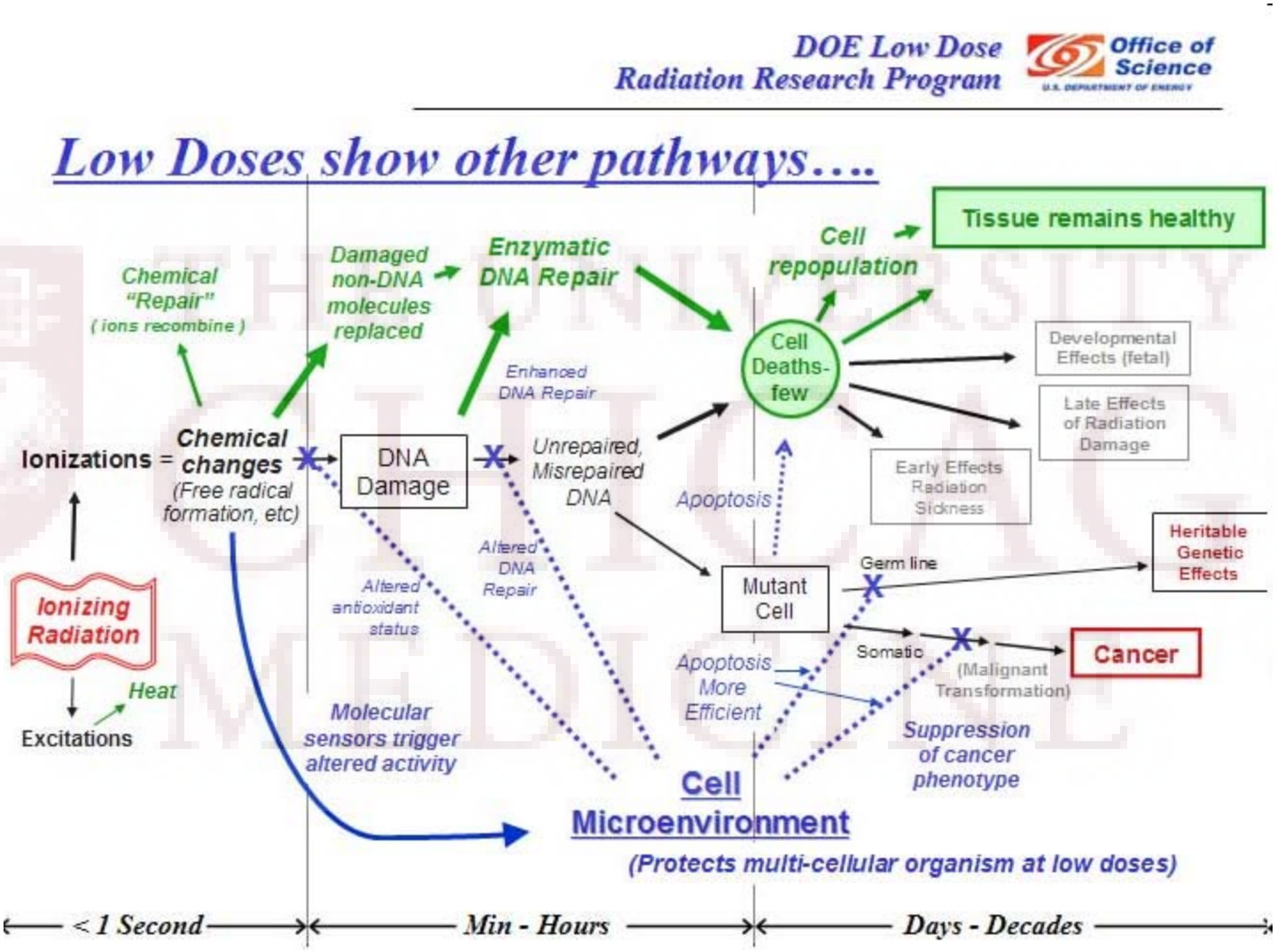
DOE Low Dose Radiation Research Program

Office of Science U.S. Department of Energy

Classic Paradigm of Radiation Injury (High Dose)




DOE Low Dose
Radiation Research Program
Office of Science
U.S. DEPARTMENT OF ENERGY
Low Doses show other pathways….
Tissue remains healthy
Cell repopulation
Enzymatic DNA Repair
Damaged non-DNA molecules replaced
Chemical "Repair" (ions recombine)
Enhanced DNA Repair
Cell Deaths-few
Developmental Effects (fetal)
Late Effects of Radiation Damage
Early Effects Radiation Sickness
Ionizations = Chemical changes (Free radical formation, etc)
DNA Damage
Unrepaired, Misrepaired DNA
Apoptosis
Heritable Genetic Effects
Germ line
Mutant Cell
Altered DNA Repair
Altered antioxidant status
Ionizing Radiation
Heat
Excitations
Somatic
(Malignant Transformation)
Cancer
Apoptosis More Efficient
Molecular sensors trigger altered activity
Suppression of cancer phenotype
Cell Microenvironment
(Protects multi-cellular organism at low doses)
< 1 Second
Min - Hours
Days - Decades

United States Radiologic Technologists Cohort

- All registered radiologic technologists certified for a minimum of 2 years (N = 146,022) as of 1982
  - Baseline questionnaire to 133,519 in 1983-1984 (90,305 responded)
  - Second questionnaire mailed to 125,707 in 1994 (91,173 responded)
  - Both questionnaires completed and returned by 70,859 technologists

Radiation Technologists cohort

- Follow-up of the cohort
  - Date of first questionnaire completion until diagnosis of thyroid cancer, death, or completion of second questionnaire
  - Participants reporting a diagnosis of thyroid cancer were contacted to obtain consent and acquire medical records
  - Era employed was considered given improvement in radiation safety over time

Characteristics of Participants with Thyroid Cancer diagnosed during the first follow-up

		Thyroid Cancer after baseline		Thyroid Cancer Free	
		N	%	N	%
Gender					
	Female	**104**	**86**	**56906**	**78**
	Male	**17**	**14**	**16053**	**22**
Age at Baseline					
	<30	**34**	**28.1**	**20690**	**28.4**
	31-40	**57**	**47.1**	**30225**	**41.4**
	41-50	**22**	**18.2**	**13484**	**18.5**
	>= 51	**8**	**6.6**	**8560**	**11.8**
Age First Worked					
	<18	**1**	**0.8**	**1383**	**1.9**
	18-20	**78**	**64.5**	**42577**	**58.4**
	>=21	**41**	**33.9**	**27260**	**37.4**
	Unknown	**1**	**0.8**	**1793**	**2.4**
Ever smoked 100 cigarettes		**55**	**45.5**	**37947**	**52**
Prior Thyroid Condition		**27**	**22.3**	**6589**	**9**

Results

- Early employment before 1950 was found to be associated with increased incident thyroid cancer before completion of the baseline survey
- The only determinant of occupational exposure that was related to prospective thyroid incidence was
  - Holding the patients for procedures at least 50 times, HR = 1.47 95% CI 1.01 – 2.15

References

- DeGroot, L, Paloyan, E 1973. Thyroid carcinoma and radiation. A Chicago endemic. JAMA 225:487
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- Tuttle R et. al. **Empiric Radioactive Iodine Dosing Regimens Frequently Exceed Maximum Tolerated Activity Levels in Elderly Patients with Thyroid Cancer.** *The Journal of Nuclear Medicine.* 2006 47:1587-1591.
- U.S. Department of Energy, Office of Science, Low Dose Radiation Research Program